Science Council of British Columbia and Indsutry Canada

Project Report: Development of Indicators for Benchmarking Innovation in British Columbia

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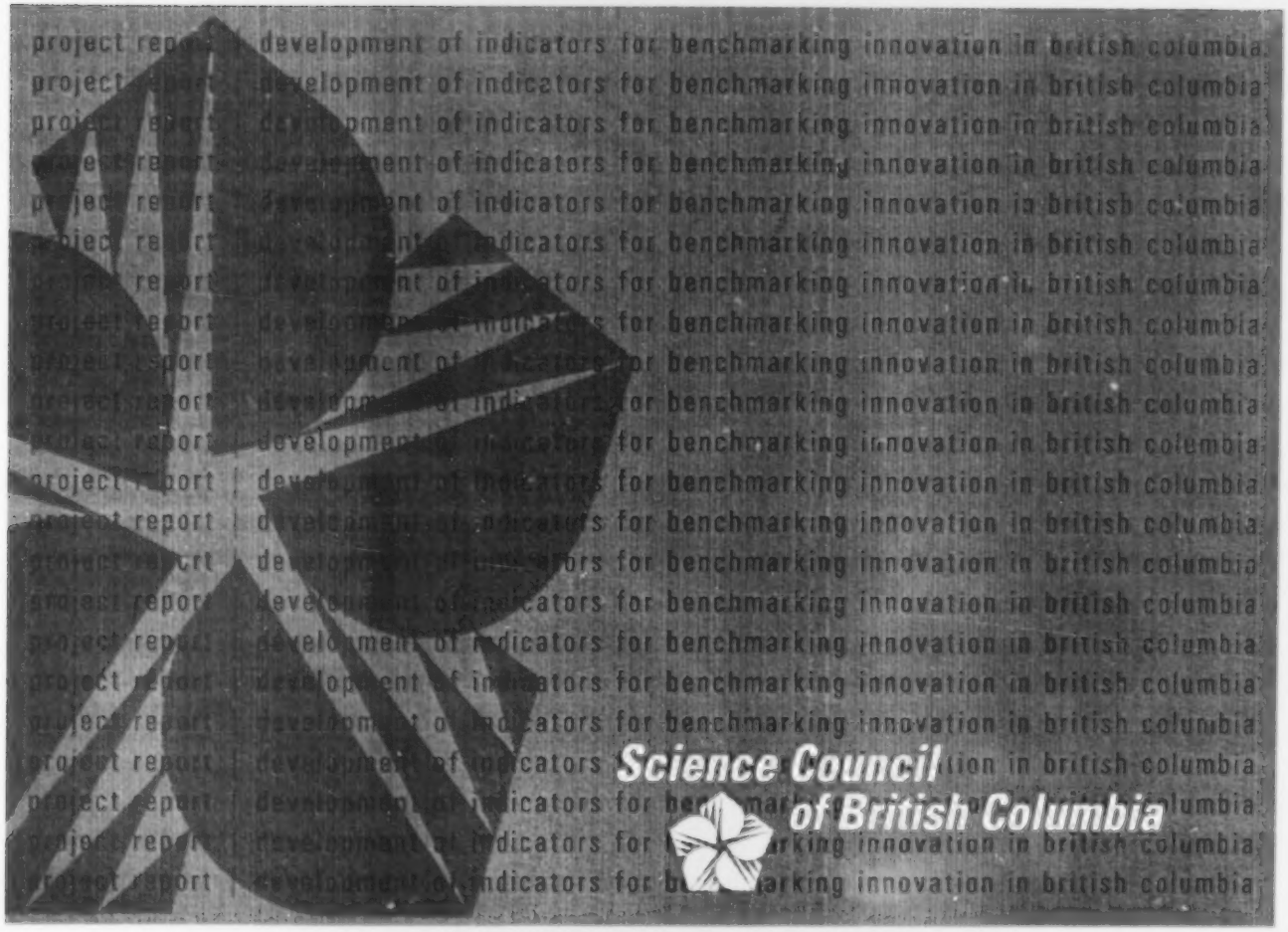
project report development of indicators for benchmarking innovation in british columbia
Science Council of British Columbia

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This staff report has been prepared by Ms. Veneranda Dettmers and is intended to serve as a basis of informed discussion and policy formation towards improving innovation performance. The preparation of this report was supported by funding provided by Industry Canada. The opinions expressed in this report are the author's.

Executive Summary

A set of 27 indicators is proposed to benchmark innovation in British Columbia and serve as a basis of informed discussion and policy formation towards improving innovation performance. The proposed set of BC innovation indicators addresses the resources or inputs side, innovation environment, and innovation outcomes. On the resources side, emphasis is on human resource skills, knowledge creation, and knowledge application.

The indicators were developed using two methodologies: comparative analysis of seven recently published innovation-related indicator reports and reader feedback on BC Innovation Benchmarks 2002 which is an initial report on BC innovation performance.

Also presented in this report are the following: framework for analyzing and interpreting innovation performance, criteria for indicator selection, benchmarks for BC performance, and format for an annual innovation benchmarks report.

This report includes the data collection and reporting and distribution plans. The data collection plan identifies the source of data, period covered, and estimated cost of data generation. The reporting and distribution plan describes responsibilities for the report and how the report will be circulated.

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1 Introduction

This project on the development of indicators for benchmarking innovation in British Columbia (BC) addresses the need to inform policy discussion and formation towards improving BC's innovation performance. It was initiated, in part, to further the activities of the Science and Technology Roundtable which brings together industry, academic and government stakeholders in developing initiatives and action plans on innovation. The project was funded by the Science Council of BC and Industry Canada.

Background

Canada's Innovation Strategy *Achieving Excellence* describes innovation as both a process and an outcome. It is the creative process of applying knowledge to the development of new products and services or to new ways of designing, producing or marketing an existing product or service for public and private markets. Many important links connect the prototype of a product or service with the market place. As an outcome, there is the characteristic newness in innovations — a world first, new to Canada or simply new to the organization that applies them.

Innovation is the key driver of long term economic growth, competitiveness and better quality of life. Innovation creates new jobs and rising incomes from the production of new products, processes and services and development of new industries. Innovation also creates competitive advantage that results from the characteristic newness and being the first in the market. Innovation leads to significant increases in productivity which creates the conditions for increased wages and a higher standard of living.

Because knowledge and innovation have become important factors of economic growth and improved social well-being, there is a growing interest among policy makers and the public in understanding innovation and the relationship between innovation and economic and social performance. Knowledge and innovation have been deliberately integrated as vital components of economic and social policies in several jurisdictions.

The need for informed discussion and decision-making in managing innovation creates a need for indicators to track progress. Indicators organize data to help draw conclusions about a subject of interest. They can measure progress through on-going measurement and facilitate comparison with others. Using selected indicators, performance is benchmarked with historical performance and with those of similar jurisdictions. Analysis helps reveal strengths, weaknesses, areas of improvement and opportunities.

Project Objectives

The project on the development of indicators for benchmarking innovation in British Columbia has three objectives:

1. Identify indicators that can be used for benchmarking innovation in BC
2. Develop a data collection plan for identified indicators
3. Develop a reporting and distribution plan for the innovation benchmarks

A set of indicators is recommended with the data to be used. The data collection plan identifies the source, period covered and estimated cost of data generation. The reporting and distribution plan describes responsibilities for the report and how the report will be circulated.

Methodology

There were two methodologies used in developing indicators to benchmark BC innovation performance:

A. Comparative analysis of innovation indicators currently used

Seven indicator reports were compared in terms of aspects of innovation measured, indicators and data used. These reports were the following:

1. Index of the Massachusetts Innovation Economy
2. OECD Science, Technology and Industry Scoreboard
3. State of the High Tech Sector in BC
4. Input Indicators of the BC High Tech Sector
5. BC Innovation Benchmarks
6. Performance Tracking Indicators of Quebec Science and Innovation System
7. Ontario Innovation Index

B. Reader survey of BC Innovation Benchmarks 2002

BC Innovation Benchmarks 2002 was an initial report on BC innovation performance. It was released in August 2002 and distributed at the BC Innovation Summit in September. A random sample of Innovation Summit participants were surveyed to generate feedback on the usefulness of the report and on suggestions regarding indicators and data.

II Comparative Analysis of Innovation Indicators

Several jurisdictions and organizations have developed indicators in recent years. The seven innovation-related indicator reports were selected for comparative analysis in this study based on the following:

- Pioneering work and most often used as a model - Index of the Massachusetts Innovation Economy
- Most number of international comparisons and jurisdictions covered and because OECD has been doing substantial work on innovation systems - OECD Science, Technology and Industry Scoreboard
- Specific to BC innovation and performance measurement work - State of the High Tech Sector in BC; Input Indicators of the BC High Tech Sector; and BC Innovation Benchmarks
- Representative of how leading Canadian provinces measure innovation - Performance Tracking Indicators of Quebec Science and Innovation System and Ontario Innovation Index

A brief description of each report is shown in Table 1. The publisher, frequency of publication, purpose of the report, number of indicators used, framework/focus and benchmarks used are described.

The comparative analysis confirms that innovation indicator reports have four general components[1]:

1. Framework which provides the context and facilitates the synthesis of findings;
2. Indicators which organize data to reveal a judgment;
3. Data which are a set of quantifiable variables used to measure dynamic phenomenon;
4. Story which provides understanding of the phenomenon and answers the question initially posed.

[1] Innovation Forum Proceedings, June 22, 1998. Massachusetts Technology Cooperative.

Table 1: Selected Innovation Indicator Reports

Index of the Massachusetts Innovation Economy
An annual publication of the Massachusetts Technology Collaborative. It uses 30 indicators that inform about the state of innovation in Massachusetts and provides comparison with similar state economies throughout the United States. It covers nine broad industry clusters that are significant to the economy.
Its framework consists of the three key components of the Massachusetts innovation economy which are the following: • Results which are outcomes for people and business such as job growth, rising average wages and export sales; • Innovation processes which are dynamic interactions that translate resources into results such as idea generation, commercialization, entrepreneurship, and business innovation; • Resources which are critical public and private inputs to the innovation economy such as human, technology, investment resources and infrastructure.
Benchmarks for Massachusetts are the national average and the six competitive leading states of California, Colorado, Connecticut, Minnesota, New Jersey and New York.
Science, Technology and Industry Scoreboard
An annual publication of the Organizations for Economic Co-operation and Development (OECD). It presents 34 indicators to analyze trends in the knowledge-based economy.
Its framework captures the changing relationship between science, innovation and economic performance in four interconnected areas which are: • Growth in the knowledge base of OECD economies; • Rising importance of the information economy; • Increasing international integration of economic activity and technology diffusion; • Economic growth and performance including the growing importance of technology and knowledge-intensive industries.
Benchmarks for each OECD country are the OECD average, European Union average and 23 other OECD countries.
State of the High Technology Sector in British Columbia: Inaugural Benchmark Report
Published in 2000 by the Science Council of BC. It presents 39 indicators to analyze the current state of the BC high technology sector.
Its framework focuses on four major categories of performance which are the following: • Resource which reflects the public and private inputs; • Innovation which reflects those interactions that translate resources into results; • Business enablers which reflect business conditions that influence interactions; • Results which reflect outcomes for people and business.
Benchmarks for BC are the provinces of Alberta, Ontario and Quebec and the US states of Washington, Oregon and Massachusetts.
Input Indicators of the British Columbia High Technology Sector
An annual publication of the BC Stats in conjunction with the Ministry of Competition, Science and Enterprise. It tracks 32 business and economic indicators that measure inputs of labour, capital, materials and knowledge/technology/information and compares them to other provinces.

Its framework focuses on the sources of inputs from the point of view of their impact on high technology firms. These sectors are the following: • Education • Business • Government • External including immigration and imports • Labour including employment of research personnel and workforce in natural and applied sciences
Benchmarks for BC are the provinces of Quebec, Ontario and Alberta.
British Columbia Innovation Benchmarks
Published in 2002 by the Science Council of BC. It presents 22 indicators that reveal BC's innovation performance and relative position compared with the national average and the provinces of Alberta, Ontario and Quebec.
Its framework focuses on the following areas that affect innovation outcomes; • Knowledge performance which includes research and development (R&D) and transfer of ideas to the market; • Skills which refers to highly qualified people, the most important resource in developing innovations in all sectors of the economy; • Innovation environment which pertains to regulations and tax system that balance the public interest with the competitive pressures faced by Canadian firms; • Strong innovative communities which involves stimulating innovation at the local level to ensure that people in all parts of Canada have the opportunity to participate in the knowledge-based economy.
Benchmarks for BC are the national average and the provinces of Quebec, Ontario and Alberta.
Performance Tracking Indicators of the Quebec Science and Innovation System
Published by the Ministry of Finance, Economy and Research as part of the annual report on the implementation of Quebec Policy on Science and Innovation. It presents 12 indicators and tracks historical performance.
It framework focuses on the following themes: • By learning and sharing science, enabling Quebec men and women to participate fully in the knowledge-based society; • Quebec scientists are contributing to the development of knowledge and to the economic, social and cultural development of Quebec; • The capacity of innovation of all organizations is being strengthened for the benefit of all Quebec men and women.
Benchmarks for Quebec when used are national average, France, United States and Japan.
Ontario Innovation Index
Published in 2002 by the Ontario Science and Innovation Council. It uses 30 indicators to show how well Ontario is performing.

Its framework focuses on aspects of national and regional innovation systems that include the following: • Community awareness and support for science and technology innovation in order to fully develop a thriving innovation culture; • Science and technology infrastructure which includes R&D, human and social capital, information infrastructure and a favourable climate for investment; • Incentives for commercialization and growth which lead to desirable outcomes from the innovation process; • Innovation performance refers to knowledge generated, diffused and used through the interaction of key players in the system, players in other supporting institutions and actors from other research bodies; • Innovation outcomes which are positive economic outcomes that will in turn facilitate a high quality of life in the province if the innovation process works well.
Benchmarks for Ontario are national average, Alberta, BC, Quebec, the US states of California, Illinois, Massachusetts, and Michigan and the country of Sweden.

Based on the comparative analysis of indicator reports, frameworks generally reflect how innovation is perceived and what the major elements are. Frameworks vary in focus. Some emphasize inputs. Many have a more comprehensive focus that covers inputs, innovation processes and interactions, environment for innovation and economic and social outcomes.

The input that is always given importance is human resource skills. The process that is highlighted is knowledge creation, application and commercialization. Major factors in the innovation environment are R&D tax incentives and income tax rates. Outcomes considered important are the impact of innovation on productivity, economic growth and income.

The selection of indicators is guided by the framework and initiatives such as the innovation strategy and sectors considered critical to building an innovation-driven economy such as the high technology and industry clusters.

Data used are those that are easily available on an on-going basis. Data generally used in comparing jurisdictions are ratios—number normalized with such factors as the total, population and Gross Domestic Product. The period covered by the data is generally ten years or the years for which data are available.

The way the indicators and data is interpreted and synthesized within the framework constitutes the innovation story. It usually points out the strengths, weaknesses, challenges and areas for improvement.

The comparison of indicators and data used in the reports reviewed is presented in Appendix 1. For purposes of grouping, indicators and data are classified into four categories: research and commercialization, human resources, innovation environment and innovation outcomes. Indicators used in at least three reports were considered commonly used and were highlighted. These commonly used indicators and data are listed in Table 2.

Table 2: Commonly Used Indicators and Data

Indicator	*Data*
Research and Commercialization	
Total research and development	GERD as % of GDP
Sectoral R & D performance (federal, provincial, business and higher education)	Sectoral R&D expenditures as % of GDP
Collaboration between business, higher education & public sector	Business funding as % of total R&D expenditures in the higher education sector
Scientific publications	Scientific publications per number of population
	Scientific publications by performing sector/subsector
Patents	Patents awarded
	Patents awarded per number of population
	Patent applications per number of population
	University patent and inventions
University technology commercialization	Gross income from university technology licenses
Venture capital investment	Amount of venture capital investment
	Venture capital investment per capita
	Venture capital as % of total
Innovative manufacturing firms	% of innovative manufacturing firms
Entrepreneurship	New business starts
	Initial public offerings
Human Resources	
Education attainment of the population	% of the population 15 years & older with post-secondary credentials
Bachelor degrees in science and engineering	Bachelor degrees in the sciences & engineering
	Bachelor degrees in the sciences & engineering per 100,000 population
Education spending	Post-secondary government spending per capita
Student performance in science and math	Grade 8 test results in math & science from TIMSS[2]
Research personnel	Research workforce per 100,000 population
Workforce in natural and applied science related occupations	% of workforce in natural & applied sciences & related occupations
Education level of immigrants	% of immigrants aged 25 years & older with 16 or more years of education
Innovation Environment	
Individual tax rate	Index of all taxes paid by unattached individuals earning $80,000 per year
Corporate income tax rate	General corporate tax rate
Cost of R&D/Tax subsidies	After-tax cost of $1 R&D expenditures
Fixed business investment	Gross fixed business investment as % of GDP
Internet connectivity	% of households using the Internet
	% of households with home computers
	% of communities with no access to broadband

[2] Trends in International Math and Science Study

	network infrastructure
Innovation Results	
Gross Domestic Product	GDP of high tech sector
	GDP of selected industry sectors
Employment	High tech sector employment
	Employment growth in selected industry sectors
	Unemployment rate
Pay/earnings	Average weekly earnings in high tech sector
	Average industry wage
Trade	High tech exports and imports
Labour productivity	GDP per hour worked or per job

III Reader Feedback

BC Innovation Benchmarks is the most recent BC publication on innovation indicators. It was an initial report to provide a base of information that could be used in the discussion of innovation issues and in planning innovation strategies. It was made public through a press release in August 2002. It was posted in the Science Council website and circulated as part of the conference kit of the BC Innovation Summit held on September 19, 2002 in Vancouver.

Reader survey on the report was conducted to measure usefulness and to ask for suggestions regarding indicators and data to be added and other improvements on the report. The feedback will serve as an input in the preparation of the next edition. A reader survey of a random sample of Innovation Summit participants was held in March 2003. A random sample size of 164 was determined to yield results at 95 percent confidence level and plus or minus five percent margin of error. Due to a very low response, the feedback from Innovation Summit participants and other readers are presented below as anecdotal.

On usefulness:
- Responses ranged from useful to somewhat useful
- Well prepared; one of the best materials in preparing for the Innovation Summit.

On format/structure:
- Great structure — one page per indicator and same page structure throughout; layout has reader in mind
- It was suggested that a highlights presentation version of the report be made available.

On indicators to be added:
- Job growth numbers and rates, strength of supporting industry/services, export performance, amount of investment; GDP per person as indicator of standard of living
- Performance of individual industry clusters such as telecom-wireless, new media, biotech, aviation, wood products, etc.
- Compare level of provincial government involvement with that of other jurisdictions that have successfully implemented an innovation strategy and has resulted in a significant improvement in the relative wealth of the jurisdiction

On other benchmarks:
- Comparison with other cities such as Calgary, Montreal, US, European and Asian cities

Other comments:
- Government has to take the lead in "innovation programs"
- Define the clusters in which the innovation breakthrough is to occur

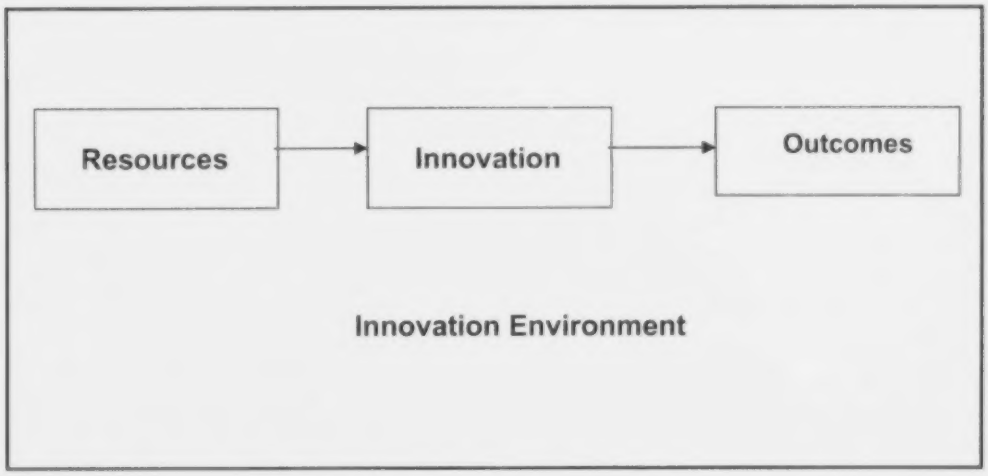
IV Proposed Innovation Indicators for BC

Based on the comparative analysis of commonly used indicators and reader feedback of the first edition of BC Innovation Benchmarks, a set of indicators for benchmarking innovation in BC is proposed along with the framework to be used, criteria for indicator selection, benchmarks and format.

Framework of BC Innovation

The framework of innovation that is comprehensive is recommended. The framework should capture not only innovation inputs, interactions and environment but also innovation outcomes. This framework would be a combination of the framework used in the Massachusetts Innovation Index and the BC Innovation Benchmarks. This is illustrated in Figure 1.

Figure 1: Framework of BC Innovation



The framework of BC innovation consists of four elements:

1. **Resources** – critical inputs directly needed for knowledge creation and application, primarily the human resource skills or the intellectual capital.
2. **Innovation** – the process and the output. The innovation process involves knowledge creation and application, commercialization and entrepreneurship as well as the interactions and linkages among players. Innovation outputs are new products and services or the new ways of designing, producing or marketing an existing product or service.
3. **Innovation Environment** - conditions that influence innovation development and processes such as business climate, government policies and infrastructure.
4. **Outcomes** - benefits to business and people from successful innovations such as productivity gains, economic growth and job growth.

Criteria for Indicator Selection

The general criteria used by indicator reports reviewed in selecting indicators are adopted. Indicators selected are those that:

- Are relevant to aspects of innovation that are important to the jurisdiction
- Measure conditions where there is active public interest
- Are based on data from objective and reliable sources
- Require data that are available on an on-going basis to allow trend analysis and comparison with other jurisdictions
- Are easily understood by a wide variety of audiences

In addition, the selection of BC innovation indicators should consider the following:

- Areas covered by the federal Innovation Strategy in the document *Achieving Excellence* and the BC innovation agenda implied in the document *Innovation in British Columbia Making the Knowledge Investment.*

- Targets of the federal Innovation Strategy which the BC provincial government has identified it can work in partnership with the federal government in meeting the innovation targets. These targets identified in the document *Innovation in BC* are the following:

  - R&D Performance: By 2010, rank among the top five countries in the world in terms of R&D performance.
  - Technology Clusters: By 2010, develop at least 10 internationally recognized technology clusters.
  - High-speed Broadband Access: By 2005, ensure that high-speed broadband access is widely available to Canadian communities and by 2010, significantly improve the innovation performance of communities across Canada.

- Technology Transfer: By 2010, rank among the world leaders in the share of private-sector sales attributable to new innovations.
- Adult Learning: Over the next five years, increase the number of adults pursuing learning opportunities by 1 million.
- Master's and Ph.D. Students: Through to 2010, increase admission of Master's and Ph.D. students at Canadian universities by an average of 5 percent per year.
- Investment Intention: By 2005, substantially improve Canada's ranking in international investment intention surveys.

- Indicators used by the BC Progress Board to measure innovation in its annual benchmarking report. These indicators are:

  - R&D as percent of GDP
  - Percent of households using the Internet
  - Percent of households owning a computer
  - Employment in natural and applied sciences and related occupations as a percent of total employment

Benchmarks

Benchmarks for BC innovation performance are proposed to be:

- National average
- Provinces of Quebec, Ontario and Alberta

Canadian benchmarks are used because the overarching goal established by the BC Progress Board is to make BC a leader in Canada by 2010 in economic growth, standards of living and jobs as well as in environmental quality, health outcomes and social condition. The national average indicates how the provinces as a group is performing. The provinces of Quebec, Ontario and Alberta together with BC represent the largest in terms of population and size of economy.

Format

Because of the commendation received on the format and structure of the BC Innovation Benchmarks, its format is proposed to be adopted. One page is devoted to each indicator. The structure is as follows:

- Indicator
- Indicator Significance in the context of innovation performance
- Data – one data set for each indicator
- BC Performance – data for the last ten years or a shorter period for which data are available
- BC Rank – data on BC's earlier and most recent performance is normalized with such factors as total, population and gross domestic product (GDP) and compared with the national average and the three Canadian provinces namely, Quebec, Ontario, Alberta

A Special Analysis section is that part of the report where the data presented are analyzed and an explanation given on the status and progress of innovation performance in BC compared with other jurisdictions. This section could also focus on specific topics such as technology transfer or cluster development.

Proposed BC Innovation Indicators

Considering the commonly used indicators, reader feedback of BC Innovation Benchmarks 2002, framework and criteria for indicator selection, there are 27 innovation indicators that are being proposed to be used for benchmarking BC innovation. Where there are several possible indicators or data, the indicator that is deemed more meaningful and the data set that is easily available are selected.

The indicators are presented within the framework adopted which has the following components: resources, innovation, innovation environment and outcomes. However, focus is placed on the areas of the federal innovation strategy which is supported by the BC government. These areas are: skills, knowledge performance, innovation environment and innovative communities. Thus, on the resource side, the focus in on skills. Knowledge performance as the terminology used in the federal strategy is adopted, knowledge creation and application being the core of the innovation process. Innovation environment deals with the conditions that favour innovation processes. The participation of and benefits to communities are addressed both in the innovation environment and innovation outcomes.

The BC innovation indicators are shown in Table 3.

Table 3: Proposed BC Innovation Indicators

Indicator	*Data*[3]
Skills	
1. Post-secondary Credentials	BC population 15 years & older with post-secondary credentials
	% of the population 15 years & older with post-secondary credentials
2. Bachelor Degrees in Science and Engineering	BC bachelor degrees in the sciences & engineering
	Bachelor degrees in the sciences & engineering per 100,000 population
3. Student Performance in Science and Math	BC Grade 8 test results in math & science in TIMSS
	Grade 8 test results in math & science in TIMSS
4. Research Personnel	Number of research workforce
	Research workforce per 100,000 population
5. Workforce in Natural and Applied Science Related Occupations	BC number of total workforce in natural & applied sciences & related occupations
	% of workforce in natural & applied sciences & related occupations
6. Education Level of Immigrants	BC number of immigrants aged 25 years & older with 16 or more years of education
	% of immigrants aged 25 years & older with 16 or more years of education
Knowledge Performance	
7. Total Research and Development	BC GERD amount
	GERD as % of GDP
8. Sectoral R & D Performance (federal, provincial, business and higher education)	BC R&D expenditures by performing sector
	Sectoral R&D expenditures as % of GDP
9. University-industry Collaboration	BC higher education R&D expenditures funded by business
	Business funding as % of total R&D expenditures in the higher education sector
10. Scientific Publications	BC number of scientific publications
	Scientific publications per 10,000 of population
11. Patents Awarded	BC number of patents awarded
	Patents awarded per 10,000 of population
12. University Technology Licensing	BC universities' gross income from technology licenses
	Gross income per technology license
13. Venture Capital Investment	BC venture capital investment amount
	Venture capital investment per capita

[3] For each indicator, first row data pertain to BC only during a given period and second row data pertain to BC data during the first and last year of the period selected normalized with a factor such as total, population or GDP and compared with the national average and Quebec, Ontario and Alberta.

14. Innovative Manufacturing Firms	BC number of innovative manufacturing firms
	% of innovative manufacturing firms
15. Entrepreneurship	BC new business starts
	New business starts per 1,000 people
Innovation Environment	
16. Individual Tax Rate	BC index of all taxes paid by unattached individuals earning $80,000 per year
	Index of all taxes paid by unattached individuals earning $80,000 per year
17. Corporate Income Tax Rate	BC General corporate tax rate
	General corporate tax rate
18. Cost of R&D/R&D Tax Incentives	BC after-tax cost of $1 R&D expenditures
	After-tax cost of $1 R&D expenditures
19. Fixed Business Investment	BC gross fixed business investment as % of GDP
	Gross fixed business investment as % of GDP
20. Internet Connectivity	BC households using the Internet
	% of households using the Internet
21. Households with Home Computers	BC households with home computers
	% of households with home computers
22. Clusters of Technology-Based Companies	BC industries with most number of high tech sector establishments
	Industries with most number of high tech sector establishments
Innovation Outcomes	
23. Labour Productivity	BC real GDP per hour worked in the business sector
	Real GDP per hour worked in the business sector
24. Gross Domestic Product	BC real GDP per capita
	Real GDP per capita
25. Employment	BC employment rate
	Employment rate
26. Income	BC real average hourly earnings
	Real average hourly earnings
27. Exports	BC exports of goods and services per capita
	Exports of goods and services per capita

V Data Collection Plan

The data collection plan describes where the data will be sourced and estimated cost if any. These are shown in Table 4.

Table 4: Sources and Cost Estimates of Data

Indicator	Data	Year/s Covered	Source	Cost Estimate
Skills				
1. Post-secondary Credentials	BC population 15 Years & older with post-secondary credentials	1991-2001	Stats Canada in BC Stats' Input Indicators of BC High Tech Sector	None
	% of the population 15 Years & older with post-secondary credentials	1991 & 2001	Same as above	None
2. Bachelor Degrees in Science and Engineering	BC bachelor degrees in the sciences & engineering	1995-2001	The University Presidents' Council	None
	Bachelor degrees in the sciences & engineering per 100,000 population	1995 & 2002	Same as above	None
3. Student Performance in Science and Math	BC Grade 8 test scores in math & science from TIMSS	1995 & 1999	Trends in International Math & Science Study	$3,000
	Grade 8 test scores in math & science from TIMSS	1995 & 1999	Same as above	Included above
4. Research Personnel	BC number research workforce	1995 & 1998	Stats Canada in BC Stats' Input Indicators of BC High Tech Sector	None
	Research workforce per 100,000 population	1995 & 1998	Same as above	None
5. Workforce in Natural and Applied Science Related Occupations	BC workforce in natural & applied science related occupations	1992-2000	BC Stats & Stats Canada in BC Progress Board Annual Benchmarking Report	None
	% of workforce in natural & applied science related occupations	1992 & 2000	BC Stats & Stats Canada in BC Progress Board Annual Benchmarking Report	None
6. Education Level of Immigrants	BC immigrants aged 25 years & older with 16 or more years of education	1991-2001	BC Stats' Input Indicators of BC High Tech Sector	None

	% of immigrants 25 years & older with 16 or more years of education	1990 & 2000	Same as above	None
Knowledge Performance				
7. Total Research and Development	BC GERD amount	1991-2001	Stats Canada: Service Bulletin Science Statistics	None
	GERD as % of GDP	1991 & 2001	Same as above	None
8. Sectoral R & D Performance	BC R&D expenditures by performing sector	1990-1999	Stats Canada in BC Stats' Input Indicators of BC High Tech Sector	None
	Sectoral R&D performance as % of GDP	1990 & 1999	Same as above	None
9. University-Industry Collaboration	BC higher education R&D expenditures funded by business	1990-2000	Stats Canada: Service Bulletin Science Statistics	None
	Business Funding as % of Total R&D Expenditures in the Higher Education Sector	1990 & 2000	Same as above	None
10. Scientific Publications	BC number of scientific publications in BC	1990-2000	Observatoire des Sciences et des Technologies (now Canadian Science and Innovation Indicators Consortium)	$5,000 member-ship in CSIIC
	Scientific publications per 10,000 population	1999 & 2000	Same as above	Included above
11 Patents Awarded	BC number of patents awarded	1990-2000	Canadian Intellectual Property Office in BC Stats' Input Indicators of BC High Tech Sector	None
	Patents awarded per 10,000 population	1990 & 2000	Same as above	None
12. University Technology Licensing	BC universities' gross income from technology licenses	1991-2000	Association of University Technology Managers	$500
	Gross income per technology license	1991 & 2000	Same as above	Included above
13. Venture Capital Investment	BC venture capital investment amount	1992-2002	Canadian Venture Capital Association in BC Stats' Input Indicators of BC High Tech Sector	None
	Venture capital investment per capita	1992 & 2002	Same as above	None

14. Innovative Manufacturing Firms	BC number of innovative manufacturing firms	1997-1999 Period	Stats Canada: Innovation in Canadian Manufacturing	None
	% of innovative manufacturing firms	1999-1999 Period	Same as above	None
15. Entrepreneurship	BC new business starts	1990-1998	Stats Canada in Ontario Innovation Index	$500
	New business starts per 1,000 people	1990 & 1998	Same as above	Included above
Innovation Environment				
16. Individual Tax Rate	BC index of all taxes paid by unattached individuals $80,000 per year	1992-2002	BC Ministry of Finance in BC Stats' Input Indicators of BC High Tech Sector	None
	Index of all taxes paid by unattached individuals earning $80,000 per year	1992 & 2002	Same as above	None
17. General Corporate Income Tax Rate	BC general corporate tax rate	1992-2002	Same as above	None
	General corporate tax rate	1992 & 2002	Same as above	None
18. Cost of R&D	BC After-tax cost of $1 R&D expenditures	1996 & 1999	Stats Canada	$3,000
	After-tax cost of $1 R&D expenditures	1996 & 1999	Stats Canada	Included above
19. Fixed Business Investment	BC gross fixed business investment as % of GDP	1991-2001	BC Stats & Stats Canada in BC Progress Board Annual Benchmarking Report	None
	Gross fixed business investment as % of GDP	2000	Same as above	None
20. Internet Connectivity	BC households using the Internet	1997 - 2001	Stats Canada in BC Stats' Input Indicators of BC High Tech Sector	None
	% of households using the Internet	2001	Same as above	None
21. Households with Home Computers	BC households with home computers	1997 - 2000	Same as above	None
	% of households with home computers	2002	Same as above	None
22. Clusters of Technology–based Companies	BC industries with most number of high tech sector establishments	1995 - 2001	BC Stats & Stats Canada in BC Stats' Input Indicators of BC High Tech Sector	None
	Industries with most number of high tech sector establishments	2000	BC Stats	$5,000

Innovation Outcomes				
23. Labour Productivity	BC real GDP per hour worked in the business sector	1992 - 2001	BC Progress Board Annual Benchmarking Report	None
	Real GDP per hour worked in the business sector	1992 & 2001	Same as above	None
24. Gross Domestic Product	BC Real GDP per capita	1992 - 2001	Same as above	None
	Real GDP per capita	1992 & 2001	Same as above	None
25. Employment	BC employment rate	1992 - 2001	Same as above	None
	Employment rate	1992 & 2001	Same as above	None
26. Income	BC real average hourly earnings	1992 - 2001	Same as above	None
	Real average hourly earnings	1992 & 2001	Same as above	None
27. Exports	BC exports of goods and services per capita	1992 - 2001	Same as above	None
	Exports of goods and services per capita	1992 & 2001	Same as above	None

VI Reporting and Distribution Plan

As a project of the Science Council of BC and Industry Canada, BC Innovation Benchmarks will be a report of the Science Council of BC Board to the BC Minister of Competition, Science and Enterprise and Federal Minister of Industry. The report preparation will be spearheaded by an advisory committee chaired by a Science Council of BC Board member.

BC Innovation Benchmarks will be made public through a press release. It will be posted in the Science Council of BC website and hard copies made available by request. Printed copies and Power Point presentation of the report highlights will also be prepared.

VII Schedule and Budget

The project duration is six months. The proposed schedule is as follows:

Activities	**Timeline (from project commencement)**
Creation of Advisory Committee and Project Start	Month 1
Data Collection	Month 2 & 3
Report Production	Month 4
Report Approval	Month 5
Report Release	Month 6

The project is estimated to cost $75,000. The budget breakdown is as follows:

Expense Item	**Budget**
Data Collection	$ 30,000
Committee Expenses: Travel, accommodation, meeting expenses	10 ,000
Personnel: Research Analyst & Administrative Support (Science Council Staff)	30,000
Report Reproduction	5,000
Total	$ 75,000

Appendix 1

Indicators and Data Used to Measure Innovation: Comparison of Selected Indicator Reports

Indicator	Index of the Massachusetts Innovation Economy	OECD Science, Technology and Industry Scoreboard	State of the High Tech Sector in BC	Input Indicators of the BC High Tech Sector	BC Innovation Benchmarks	Performance Tracking Indicators of Quebec Science & Innovation System	Ontario Innovation Index
Research and Commercialization							
Total Research and Development		GERD as % of GDP	GERD as % of GDP	GERD as % of GDP	GERD as % of GDP		GERD as % of GDP
		GERD growth rate		GERD amount	GERD amount		GERD per capita
Sectoral R & D Performance (federal, provincial, business and higher education)		R&D expenditures as % of GDP by source of financing and by performing sector	Sectoral R&D expenditures as % of total R&D	Sectoral R&D expenditures as % of GDP	Sectoral R&D as % of GDP		R&D expenditures by performing sector
	R&D expenses per employee for publicly-traded companies; Corporate R&D per employee by industry cluster, publicly-traded companies with R&D expenditures	Business R&D growth rate; Share of services & manufacturing in business R&D; Share of business R&D by size class; Share of govt. financed business R&D by size class					
	Federal R&D expenditures in academic & nonprofit research institutions and per 1,000 people						
R&D in specific fields		Software R&D as % of GDP	R&D expenditures per unit of gross output, high tech sector				
						Research funding for social sciences & humanities	
		Business R&D expenditure as % of selected ICT mfg. & services industries	R&D expenditures in natural sciences & engineering (NSE) as % of high tech GDP; Industry R&D expenditures in NSE & per high tech worker				

Highlighted row = commonly used

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		Public funding of biotechnology R&D	Govt. R&D expenditures in NSE; Govt. R&D expenditures in NSE, total and by objective				
		Environmental R&D in govt. budget					
	US Dept. of Health & Human Services R&D expenditures per 1,000 people	Health R&D in govt. budget					
		Defence R&D in govt budgets					
		Basic research as % of GDP					
Collaboration between business, higher education & public sector		% business funding of research performed by govt. & higher education	Industry funding as % of total R&D expenditures in the higher education sector		Business funding as % of total R&D expenditures in the higher education sector		
					Higher education R&D expenditures funded by business	Funding by industry of university research	
			University research sponsored by non-govt. grants, contracts & donations			Funding of university research by federal research funds	
		Share of firms with cooperation arrangements with govt. or higher education					
Collaboration among firms & strategic alliances		Cumulative number of deals; Cross-border strategic alliances					% innovative manufacturing firms with co-operative and collaborative arrangements
International cooperation in S&T		% of scientific publications with a foreign co-author;				Rate of int'l. collaboration (joint publications)	% of papers involving int'l. collaboration in the natural, biomedical & eng. fields

Highlighted row = commonly used

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		% of patents with foreign co-inventors					
Scientific Publications		Scientific & technical articles per million population			Scientific publications per 10,000 population		Scientific publications per capita
			Number of scientific publications		Number of scientific publications		
		Scientific & technical articles by field	Scientific publications by subsector				Distribution of scientific puoli ations by performing sector; Specialization index
							Publications per professor in the natural, biomedical & eng fields
						Impact factor of publications	Relative weighted impact factoring the natural, biomedical & eng fields
Patents	Patents issued to residents		Patents awarded		Patents awarded		Individual & institutional inventions
		Patents per million population	Patent awards per 100,000 population	Patents awarded per 10,000 persons	Patents awarded per 10,000 Population		Individual inventions per million population
		Patent applications per million population	Patent applications per 100,000 population	Patents applications per 10,000 persons			
	Distribution of patents issued by industry clusters	Patent applications divided by business R&D expenditures					
		Patent applications owned by foreign residents & invented abroad; Foreign ownership of domestic inventions; Domestic ownership of inventions made abroad					

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	Number of new patent applications, filed each year by major universities, hospitals and nonprofit research institutions		Patents activity at major universities; University inventions/patents activities as % of total;				University patents & inventions
			US patent applications and awards from Canadian universities	US patents issued to selected institutions (universities)			
		Biotechnology patents as % of total patents filed					
		ICT patents as % of total nat'l. patents filed					
University technology commercialization	Number of invention disclosures received by major universities, hospitals and nonprofit research institutions						
	Number of technology licenses issued by major universities, hospitals and nonprofit research institutions				Number of licenses		
	Value of gross licensing income received by universities, hospitals and nonprofit research institutions		University technology licensing income; Gross royalties and licensing income	Gross income from technology licenses in selected universities	Gross income per technology license in selected universities		Income from university technology license
	Total number of investigational medical devices, premarket approvals and biotech drugs approved by the FDA						
			Spinoff companies from university research; Public listed spinoff companies and their market capitalization				Spin-off companies from universities per $100M sponsored research

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			Govt. funding to Technology Transfer Centres				
Venture capital investment	Total venture capital investment		Venture capital investment	Venture capital investment	Venture capital investment		Venture capital investment
				Venture capital investment per capita	Venture capital investment per capita		Venture capital investment per capita
	Venture capital as % share of total US		Venture capital as % of total Canadian	Venture capital as % of total Canadian			
		Venture capital investment as % of GDP					
	Venture capital investment by sector	Share of high tech sectors in total venture capital					
Innovative manufacturing firms		% of innovative firms in mfg. & services sectors			% of innovative manufacturing firms		% of innovative manufacturing firms
		Expenditure on innovation as % of sales			Impact on Sales in 1999 of New Products		
Technology adoption rates			Technology "in use" in selected functions in manufacturing industry, Technology used by Canadians				% of mfg. firms using at least one advanced technology
							Source/approach to introduction of advanced technology
Entrepreneurship	Number of new business incorporations and by category		New high tech establishments and by major sector (mfg. & services) and by selected subsectors	Entries and exits to the BC high technology sector as a ratio of total entries to all sectors			New business starts & new businesses per 1,000 people
				Exits to the BC high technology sector as a ratio of total exits to all sectors			New businesses per capita
	Total number of initial public offerings		Initial public offerings, high tech sector		Initial public offerings		Number & average value of IPO
	Total number of mergers & acquisitions activity	Cross border mergers & acquisitions in the ICT sector					

Highlighted row = commonly used

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	Number & value of Small Business Innovation Research Program awards to MA companies				Market value of BC T-Net 20 Index		
	Annual growth rate of total market capitalization		Market value of T-Net 20 Index				
	Average annual growth rate of NASDAQ companies' market value by clusters						
	Distribution of publicly-traded fast growth			Growth companies (gazelles) in the BC high tech sector			
Business innovation	Corporate headquarters & "technology fast 500" companies located in Massachusetts						
Human Resources							
Education attainment of the population				% of the population 15 years & older with a high school diploma		Graduation rates in high school, junior college & bachelor's degree	
		% of population aged 25-64 with at least an upper secondary education level		% of the population 15 years & older with post-secondary credentials	% of the population 15 years & older with post-secondary credentials		% of the population 15 years & older by highest degree, diploma or certificate
						Graduates earning master's & doctoral degrees; % women of degrees granted	
Educational attainment of the workforce			Education levels of the high tech workforce				% of the labour force with university backgrounds in science, engineering or business
Bachelor degrees in science and engineering	Engineering degrees awarded		Bachelor degrees in the sciences & engineering		Bachelor degrees in the sciences & engineering	Graduates in pure and applied sciences	Graduates in the natural sciences & engineering

Highlighted row = commonly used

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			Bachelor degrees in selected science disciplines per 100,000 population	Engineering and computer science bachelor degrees awarded per 100,000 persons aged 15 years and older	Bachelor degrees in the sciences & engineering per 100,000 population		
	Computer & information science degrees awarded		Graduates in computer sciences (bachelor & diplomas)				
							Bachelor's & 1st professional degrees awarded in selected fields of study
Mobility of human capital		Non-US OECD citizens with science & eng. doctorates in the US; Relative share of non-national S&T human resources employment in the EU					
		Foreign students as % of total enrolment and distribution by field of study					
University enrollments	% change in total enrollment, public & private degree granting institutions		Enrollment & % increase in enrollment in engineering, sciences & technology programs; % of admissions to applications in sciences & engineering				
			Student co-op placements in high tech disciplines				
Education spending	Appropriation for operational expenses of public higher education per capita;	Expenditure per student for tertiary level education	Post-secondary govt. spending per capita				

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Indicators and Data Used to Measure Innovation: Comparison of Selected Indicator Reports

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	Average four-year tuition at private and public colleges & universities		K-12 public education spending per student; Education spending, all levels				
Grade school math and science assessments/ Student performance in science & math					Average marks in provincial science & math exams		
			Grade 8 test results in math & science from TIMSS		Grade 8 test results in math & science from TIMSS		Grade 8 science scores in TIMSS
				Grade 12 Test results in advanced math & physics		Grade 10 test results in math & science in TIMSS	
							Students' attitudes toward science
School teachers with backgrounds in science and technology							Field of specialization for highest degree, secondary school teachers
							Retirements of subject-qualified secondary school teachers by 2010
Enrolment in secondary school science courses							Total publicly funded school enrolments in science courses in Grade 11 and over
							Total enrolment in science courses, Grade 11 & above, by field of study
							Enrolment in science courses in Grade 11 & above by field of study as a % of total science course enrolments
Student interest in engineering & science	% of students taking the Scholastic Aptitude Test intending to major in engineering and in the sciences						

Highlighted row = commonly used

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High school drop out	High school drop out rate & by race/ethnicity						
Research personnel		Researchers per 10,000 labour force	R&D personnel as % of total employment	Research workforce per 100,000 persons	Research workforce per 100,000 population		Researchers per 1,000 persons in the labour force
		Business researchers per 10,000 labour force			Research workforce		
			R&D workforce by performing sector; R&D personnel of federal research labs	Research workforce by sector			
Workforce in natural and applied science related occupations	Scientists & engineers as a % of total labour force	Scientists and engineers as % of labour force			% of workforce in natural & applied sciences & related occupations	% of high knowledge workers in total labour force	
		Human resources in S&T employment growth					
		% of high & low skills within the ICT-related occupations					
Education level of immigrants			% of immigrants with high tech related occupations to total immigrants & per 1,000 immigrants	% of immigrants 25 years & older with 16 or more years of education	% of immigrants aged 25 years & older with 16 or more years of education		
				Median years of schooling of immigrants 25 years and older			
Migration	International in-migration & domestic out-migration; Distribution by ethnic group of immigrants intending to reside in MA		Ratio of outflow to inflow from permanent migration between Canada & the US, selected professions; Location of 1991 graduates in computer science & engineering; Departing employee destination, high tech sector				

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Employee turnover			Employee turnover rate				
Population growth	Average annual population growth rate						
Innovation Environment							
Individual tax rate			Effective personal tax rate for single unattached earning $80,000	Index of all taxes paid by unattached individuals earning $80,000 per year	Index of all taxes paid by unattached individuals earning $80,000 per year		Personal income tax rates
Corporate income tax rate			Top corporate tax rate	General corporate tax rate	General corporate tax rate		Corporate income tax rates
			Top combined effective tax rates for large mfg. & non-mfg. & small general firms	Small business tax rate			Marginal individual capital gains tax rates
Cost of R&D/R&D tax incentives		Rate and change in the rate of tax subsidies (1-B index)	After-tax cost of $1 R&D expenditures		After-tax cost of $1 R&D expenditures		B-index score (large and small mfg. firms)
			Tax credits earned from federal SRED				
			Cost of provincial incentive & support programs				
Fixed business investment/investment in machinery & equipment		Gross fixed capital formation as a % of GDP and of which % of machinery & equipment			Gross fixed business investment as % of GDP		Investment in machinery & equipment as a % of GDP
		% ICT gross fixed capital formation					Investment in machinery & equipment in selected industries as % of total; Total investment in machinery & equipment in selected industries
Direct investment		Inward & outward FDI flows and as % of GDP	FDI investment and as % of GDP				

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Foreign affiliates		Share of foreign affiliates in manufacturing & service turnover & employment; R&D expenditures by foreign affiliates and national firms					
Perception of business climate	% of high-tech CEOs rating MA "good" or "outstanding" as a place to crate, operate & expand high-tech businesses						
	Consumer confidence index						
Global integration of economic activity		Trends in international transaction by components					
Business costs			Average business cost index				
Infrastructure resources	Median price of single-family homes; Home ownership rates						
		Telecommunications access paths per 100 inhabitants; ICT expenditures as % of GDP					
			Capital expenditures per capital, telecommunications industry				
Inter-provincial migration				Net inter-provincial migration	Net inter-provincial migration		
					Net inter-provincial migration per 1,000 population		

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Cultural diversity							Immigrant population as a share of total population; Foreign born population as % of total population
Crime rates							Property & violent crime per 100,000 population
Air quality							10-year range of maximum one-hour ozone levels and of composite annual mean for PM10 concentration
Connectivity and Clustering							
Internet connectivity	% of homes with Internet access	Households with access to Internet;	% of households using the Internet	% of households using the Internet from any location	% of households using the Internet	Internet access of households	Use of the Internet from the home; Internet access rate from any location
		Individuals using the Internet from any location;	% of Canadians accessing the Internet				
		Households with access to a home computer	% of households owning computers	% of households with home computers			
	Students per Internet-connecter computer; Schools that access the Internet through a high-speed connection Easiest & most difficult states for Internet users						
		Internet penetration by industry; Businesses with Internet & Web sites		% of small businesses using the Internet			
			Small & medium enterprises adoption of e-business				

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		DSL & cable modem lines per 100 inhabitants; Broadband penetration rates			% of communities with no access to broadband network infrastructure		Subscribers to high-speed internet by cable
		Internet subscribers per 100 inhabitants; Internet hosts per 1,000 inhabitants; Websites per 1,000 inhabitants					
		Internet/web purchases and sales; % of individuals using & ordering goods & services over the Internet					
		Price of leased lines and of 40 ours of Internet use					
Clusters of technology-based companies	Nine key industry clusters				High tech sector establishments by region		
					Industries with most number of high tech sector establishments		
Innovation Outcomes							
Contribution to GDP		GDP per capita					GDP per capita
		Share of ICT value added in business sector value added;	High tech sector GDP & as % of total GDP	High tech sector GDP & as % of total GDP	High tech sector GDP; High tech sector growth		
		% of total gross value added of sectors—agri, construction, FIRE etc;	Selected industry sectors GDP as % of total GDP				Distribution of GDP by selected industries

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		% of high and medium high tech manufacturers and knowledge-intensive services to gross value added					
Employment	Total employment and net employment change, nine key clusters	ICT employment in business sector	High tech sector employment & as % of total employment	High tech sector employment & as % of total employment			Total employment & employment growth in high tech industries
	Employment concentration & growth, nine key industry clusters		Employment change in selected industry sectors				% increase in total employment for selected R&D intensive industries
							Labour force in management, business, sciences & engineering
							Employment in selected knowledge-intensive sectors
	Unemployment rate overall		Unemployment rate, overall & science & high tech related	Unemployment rate for natural & applied sciences occupations			
	Difficulty in hiring qualified personnel for selected technical positions & functions			Ratio of unemployment rates for science occupations to total labour force			
Pay/earnings	Average pay per worker		High tech average annual salaries	High tech average weekly earnings			Average weekly earnings & selected industries
	Cluster industry wage growth rate		Average wage high tech vs. industrial aggregate;				Average ON pay, selected R&D intensive industries
			Base salary as % of total cash compensation, high tech sector; Earnings distribution in high tech sector – top, middle and low 20%				
Household income	Median household income	Income levels in the OECD					

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Exports/Imports (Trade)		ICT manufacturing trade	High tech exports and imports; High tech trade change over time	Value of high technology imports			High technology exports & growth
			High tech geographic export markets and export commodity groups				High technology exports destination
	Value & % change in value of mfg. exports per employee	Trade in goods & in services as % of GDP;					
		Manufacturing trade by technology intensity/high-low tech; Contribution to the mfg. trade balance by technology intensity					
Technology balance of payments		Technological payments & receipts (flows); Flows as % of GDP					
Job opportunities	Total number of Internet job postings		Employee turnover rate in selected high tech sub-sectors				
Labour productivity		GDP per hour worked	Productivity gains by major high tech sectors and industry sectors				Average GDP per job
		Labour productivity by industry					Sectoral productivity
Revenue			High tech industry revenues	High tech industry revenues			
Profitability			% of profitable firms; Years to profitability				
Health							Health index
							Leisure time physical activity
							% of population who are smokers & quitters

Highlighted row = commonly used

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Community Awareness & Support for Science and Technology Innovation							
Coverage of science and technology in the press							Awareness of science-related key words in major ON newspapers; Appearance of science-related key words in ON regional newspapers; Appearance of the key word "technology" in major and regional ON newspapers

Highlighted row = commonly used